Metaverse as Tech for Good: Current Progress and Emerging Opportunities

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Metaverse as Tech for Good: Current Progress and Emerging Opportunities

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Abstract: Metaverse is an upcoming transformative technology that will impact our future society with immersive experiences. The recent surge in the adoption of new technologies and innovations in connectivity, interaction technology, and artificial realities can fundamentally change the digital world. The Metaverse concept is the most recent trend to encapsulate and define the potential new digital landscape. However, with the introduction of 5G with high speed and low latency advancements in the hardware and software with the graphics power to display millions of polygons in 3D and blockchain technology, this concept is no longer fiction. This transition from today's Internet to a spatially embodied Internet is, at its core, a transition from 2D to 3D interactions taking place in multiple virtual universes. In recent years, augmented virtual reality has created possibilities in the private and professional spheres. The new Virtual Reality (VR) headsets and Augmented Reality (AR) glasses can provide immersion in the physical sense. Technology must offer realistic experiences for users to turn this concept into reality. This paper focuses on the potential use cases and benefits of the Metaverse as a tech for good. The research paper outlines the potential areas where a positive impact could occur, highlights recent progress, and discusses the issues around trust, ethics, and cognitive load.

Keywords: metaverse; augmented reality; virtual reality; immersive technology; extended reality; 5G

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1. Introduction

Imagine a new universe free from the physical realities of your life where you can work, play, connect with people, and relax anywhere you want on the planet. With opportunities to attend gatherings and do anything that you can imagine in reality, this dream is not far now. Now it is the beginning of the Metaverse as the next evolutionary stage of the Internet towards decentralized using Augmented Reality (AR) and Virtual Reality (VR) [1]. AR overlays digital information onto the real-world environment to enhance the real-world perception with digital elements, VR creates entirely immerses computer-generated environments by blocking out the physical world, while Mixed Reality (MR) enables users to interact with digital and physical objects simultaneously by blending digital content into the real world [2]. This world will not be one specific virtual world but multiple shared virtual universes that coexist to form a rich tapestry of existence [3]. Our current virtual world environments, such as Pokémon Go, Robolox, World of Warcraft, are used by millions daily [4]. These form a beta Metaverse which gives a glimpse of the potential of this technology. Recent innovations can allow the fidelity and complexity of these worlds to become genuinely complete experiences for the good of humanity.

What Is the Metaverse?

The concept of the Metaverse refers to a shared persistent virtual world environment where people can interact just like in the real world [5]. This concept of the Metaverse is not new; it is a term acquired from the science-fiction novel Snowcrash [6], and has now become a byword for a future version of the Internet using VR and AR technology

to interact instead of using desktops, laptops and mobile phones [7]. One of the most prominent examples of developers attempting to create such a virtual world was Second Life [8]. However, its implementation is entirely for the gamer community. It is one of the first Massive multiplayer online games to have shown us the potential and effects of these shared worlds. *Metaverse refers to shared digital spaces with a realism approach using* VR or AR.

Metaverse is also used to describe gaming worlds where every user can have a virtual character to interact with other players' virtual characters. Taking the VR from gaming to this virtual world for practically everything, Metaverse will be for work, education, healthcare, conferences, play, concerts, or just hanging out [9]. The concept of the Metaverse holds significant potential for positive societal impact and "tech for good" applications. "Tech for good" is a concept that refers to the use of technology and innovation to create positive and beneficial outcomes for individuals, communities, and society as a whole. It involves leveraging technological advancements to address social, environmental, and humanitarian challenges, with the aim of improving people's lives and promoting well-being. "Tech for good" initiatives focus on developing and deploying technological solutions that contribute to sustainable development, equality, inclusivity, and positive societal impact.

2. Historical Background of Metaverse

This journey started with the Internet simply allowing people to send emails and chat on BBS (Bulletin Board System) message boards [10]. In 1989, Tim Berners-Lee created the World Wide Web to connect the Internet through a web browser [11], which allowed for the creation of millions of different websites and is still growing every day. This all later created things like Yahoo and Google, leading to the advent of Web 2.0 for user-generated content like blogging, which eventually morphed into social media. Today, we care about using different apps and websites for connection through the Internet. The concept behind the Metaverse is to create new online spaces for more multidimensional interactions for people by enabling an immersive experience instead of just viewing. We are starting to think about the Metaverse as the place for all possible resources to come together, but not something whose final form exists yet; it will take a few more years. However, technological limitations will decrease with time as Internet speed and hardware resources will grow more advanced. These innovations are being invented on the foundation of the Internet. Living today, we use an app-based layer that allows us to engage through apps on smartphones like Facebook, Twitter, Snapchat, Zoom, Instagram, and so on. The upcoming layer for connectivity is the Metaverse. With the haptic feedback using wearables [12], sensory experiences like touch can bring more realism with a wider adoption [13].

Why Now?

An ideal immersive experience needs a very high-speed internet connection which was not possible before. Recently COVID has increased the race of virtual technologies (just like it increased the need for touchless interaction technologies [14]), which are becoming possible due to the availability of 5G Internet [15], fast computer processing powers, and strong chips [16]. So realistically, technology is moving very fast toward a Super Smart Society named "Society 5.0" by the Japanese Government [17] as shown in Figure 1.

The idea behind Society 5.0 is using technologies like Artificial Intelligence (AI), Machine Learning, Augmented/Virtual Reality [18], Blockchain, Web 3.0, and the use of 5G and 6G to make the 21st century more connected, liberated from various constraints and free for diverse lifestyles.

The most crucial factor in these interactions is if a user feels a sense of presence. This can be achieved by producing sufficiently realistic user interaction to feel psychologically and emotionally immersed [19]? To imagine all the possibilities of the Metaverse concept into reality in the real world, we have to read history books of the digital world we live in today and see how this digital transformation happened in the last four decades (as explained in Figure 2). Thanks to a high level and quality resolution, the level of fidelity

will reach a threshold that all will consider the Metaverse objectively. It will lead towards a more immersive entertainment experience with full engagement of all the senses.

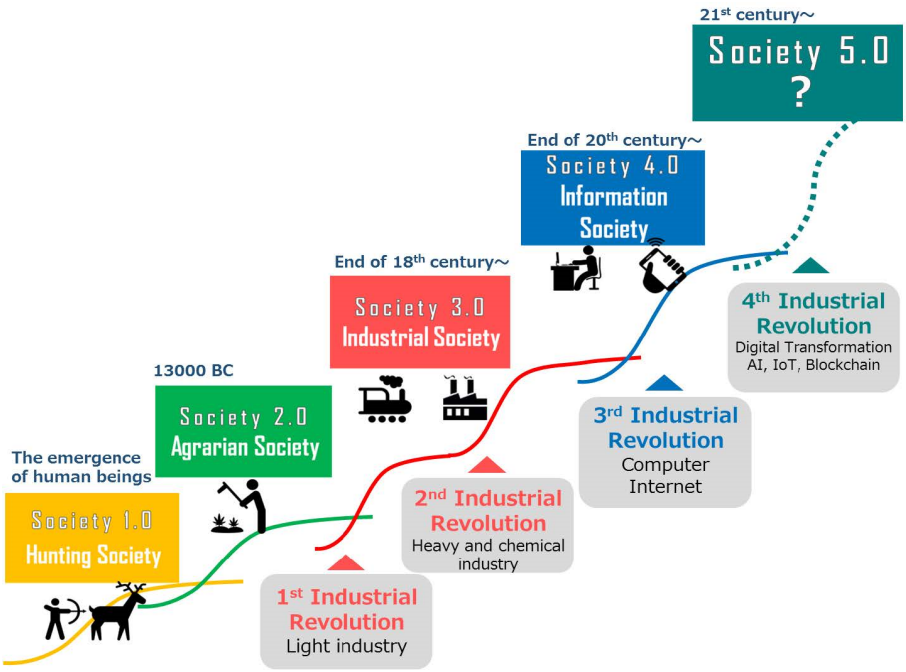

Figure 1. Society 5.0 as described by the Japanese government, "Super Smart Society" [17].

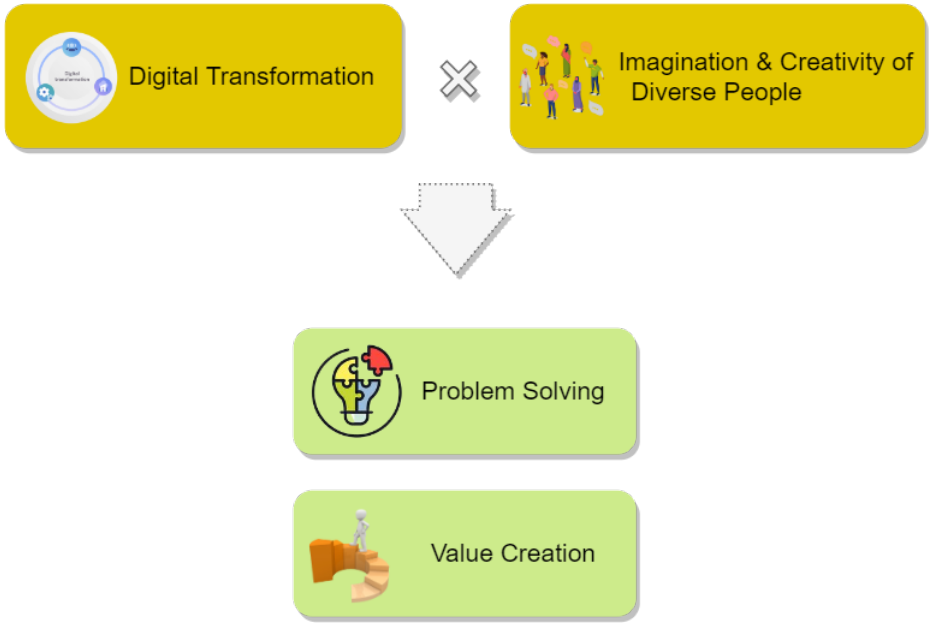

Figure 2. Digital Transformation and Creativity to solve problems and creating value.

Facebook is shifting from 'social networking' towards 'social technology' as Meta is trying to enlarge the business from communications to retail, working stations, education, leisure, entertainment, and healthcare [20–22]. A clear opportunity can be seen in this big leap; the use of digital twins, realistic consultations using avatars, personalized care, diagnosis through data interconnectivity, and simplified payment. The Metaverse as an idea is a place to experience reality without having reality. This transformation will transform the ways of social interactions, training, working, gaming, and learning.

The Metaverse can fundamentally change how we interact with technology, social experience, and online collaborations. Digitizing the actual surroundings in reality as

its best version will enable human interaction with cartoonish avatars (*avatar is a virtual character to represent humans in the virtual world*) in pre-built virtual worlds.

3. Discussion on the Potential and Progress of the Metaverse

The Metaverse, in general, looks like a souped-up version of VR, but it can be the future Internet. Instead of sitting in front of a computer and working, the Metaverse can use a headset to enter the virtual world connecting digital environments.

3.1. Potential of Metaverse at Workplaces

COVID-19 brought a forced work-from-home strategy, which later turned into a hybrid model of working as a new normal. Also, a four-day working week is being trialed in different parts of the world and is considered a more effective and mental health-friendly option.

As the world has adopted an approach of hybrid working strategy, interest in the Metaverse increases and its capability of connecting employees in the future workplace will be more obvious. With increasing innovations in AR and MR technology, the way to work and socialize can be transformed fundamentally. Figures 3 and 4 have explained the Metaverse concept for the workplace using Horizon Workrooms.

Figure 3. Metaverse as co-working space which can enable the realism [23].

Figure 4. Facebook's Horizon Workrooms with mixed reality experience [24].

The current video communication will be replaced with sitting next to a hologram of a person you want to meet. This could be your own private virtual shared world or one in which you could freely stop by like a public park. Wearing glasses to enter an entirely new world is a fantastic concept for entertainment and gaming purposes, as well as a significant step towards a new future for productivity and virtual collaboration. Microsoft developed Mesh for Microsoft Teams which can enable the presence and provide shared experiences through mixed reality applications on smartphones, tablets, desktop PCs, VR headsets, or HoloLens and allow users to represent with 2D and 3D avatars [25].

Avoiding "Zoom Fatigue"

Zoom is the most widely adopted software during the pandemic. The employees meet their colleagues online through online video meetings. However, the continuous use of these interactions is exhausting in the long run. The Metaverse can help employees avoid this fatigue by making more realistic interactions in more authentic ways.

The main reasons behind this "Zoom Fatigue" are excessive amounts of eye contact with increased cognitive load, seeing our real-time camera feed, and increasing constraints on physical mobility [26,27]. However, due to its more realistic and engaging experience, the Metaverse can help avoid some of these causes, like helping in avoiding own camera feeds and lifting constraints from physical mobility. Moreover, with the possibilities of realistic interactions in less exhausting and more authentic ways, integrating the Metaverse into the working day will become easier.

3.2. Potential of Metaverse in Education

Across the globe, XR is becoming an integral part of the educational systems that will move forward to the Metaverse. Figure 5 explains the educational applications of Metaverse. Education has rich traditional practices of classrooms, curriculum structures, grading systems, etc., but so far in the digital transformation, it is impossible to turn it into virtual spaces completely. This need emerged during the COVID pandemic when the world felt the need for virtual classrooms [28]. As an immersive virtual space, the Metaverse concept can bring the campus activities and class lectures with 3D simulations to enable a more realistic classroom learning experience where everyone presents virtually in an immersive form [29]. With the involvement of activity-oriented and enhanced gamification, it can increase classroom participation [30].

Metaverse's applications in education include, but are not limited to, virtual 3D classrooms, simulated real-life situations, digital learning in a remote setting, interdisciplinary learning, virtual campus tours, events, and collaborative activities. It can help to create powerful immersive learning experiences, gamification, hands-on learning practices, and improve learning speed.

By bringing the concept of social presence, Metaverse can help students to meet and interact virtually with other students and teachers in 3D virtual classrooms. Metaverse's ability to replicate real-life situations where students can conduct scientific experiments can revolutionize STEM learning, especially in resource-constrained environments. A prototype of a campus Metaverse at the Chinese University of Hong Kong, Shenzhen (CUHKSZ) was presented with a blockchain-driven system (explained in Figure 6). The system aims to provide an on-campus interactive Metaverse for students with a mixed environment where students' real-world actions reflect in the virtual world [31].

Figure 5. Metaverse's applications in education.

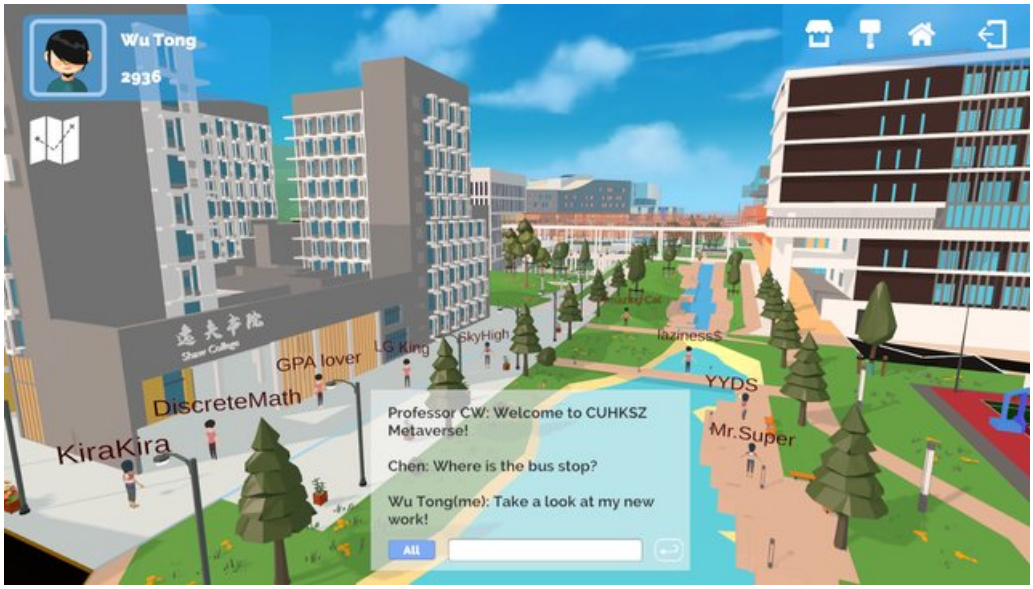

Figure 6. A corner of the Chinese University of Hong Kong, Shenzhen (CUHKSZ) as Metaverse [31].

The exciting thing about the Metaverse in the context of education is, learning seems to be a perfect fit as it will empower learning by doing "kinesthetic learning" [32] at its best with simulated activities about experiential learning. In 2021, Stanford University started its course COMM 166/266: "Virtual People" completely based on virtual reality [33]. The evaluation of a collaborative e-learning Metaverse platform, VoRtex shows positive results in overcoming the learning boundaries [34]. A bottom-up approach adopted for

real case studies to use Metaverse-based education has been shown to create Sustainable Learning experiences [35].

Learning technical topics and training in remote and resource-constrained environments is possible using artificial technologies, and the concept of haptic feedback can take this approach to the next level. Using haptic sensing gloves would allow interaction with the virtual world and experience it in the same way as we do in the real world. In artificial reality, the goal of haptic technology is comfortable and lightweight gloves to convey tactile information such as pressure, heat, and weight. Suzuki et al. used the concept for the learning system in Metaverse [36]. Figure 7 shows the Meta haptic gloves for technical training.

Figure 7. Haptic feedback gloves revealed by Facebook Reality Labs (Meta Reality Lab) [37].

3.3. Potential of Metaverse in Gaming Industry

Gaming industry is the leader in developing of the Metaverse. The emergence of the Metaverse concept created a boom in gaming cryptos for the Metaverse gaming experiences. Experimentation in spaces like 'decentraland' and many others shows that gamers are developing the Metaverse. With an estimated 3 billion people playing video games globally, there are entire infrastructures that create significant opportunities for wealth creation. According to BITKRAFT Ventures, video games represent a USD 336 billion industry [38] (visualized in Figure 8) with widespread software, hardware, and intellectual property. Figure 9 shows the volume of the gaming industry. Minecraft and MinecraftEdu are those gamification experiences used in the Metaverse concept [39]. Minecraft is a sandbox video game that allows players to build and explore virtual worlds made up of blocks. MinecraftEdu is an educational version of Minecraft that allows instructors to use the game as an educational tool. Niantic, the creator of Pokémon Go, raised USD 300 million in funding to create its metaverse [40]. In addition, Niantic is developing an AR platform for 3D models of the planet, which can play a significant role in the upcoming computing revolution.

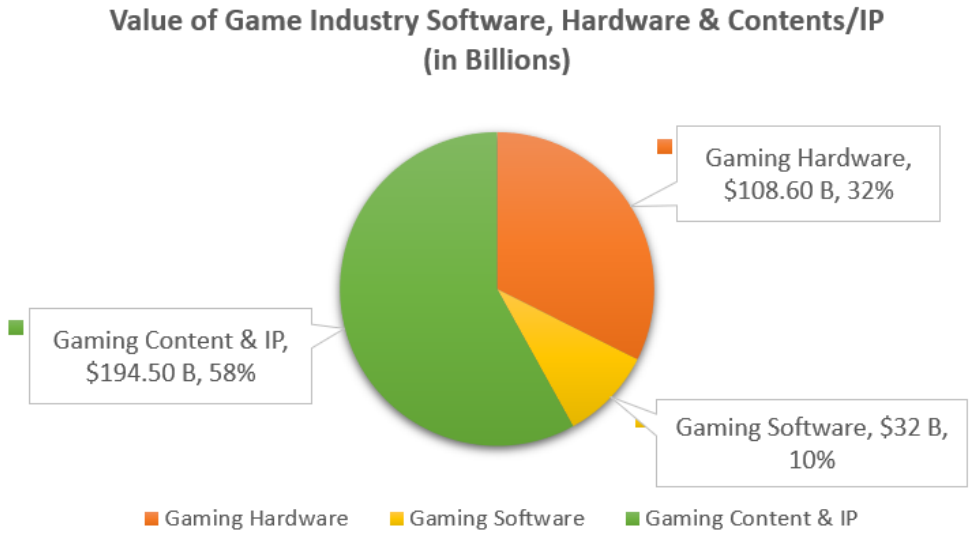

Figure 8. Marketvalue of gaming industry in 2021 [38].

Figure 9. A snapshot of using Metaverse for gaming [41].

Play-to-Earn as a New Economic Model for Gaming

Recently, the gaming industry has grown massively, adopting the play-to-earn gaming model to financially reward every user who is adding value by playing in the gaming ecosystem. Moreover, with the use of new technologies like AI imaging and motion capture, developers can develop more realistic 3D worlds for gamers.

In a new move, the gaming industry is becoming decentralized. Play-to-earn games can bring digital identity, assets, and ownership for players in the digital world [42].

3.4. Potential of Metaverse for Entertainment

Entertainment is a big industry with various sectors divided into two broad categories: content and experiences. Entertainment content is turning to digital with the latest technologies very fast in the last two decades, and experiences are moving away from offline and cinemas to virtual spaces.

The years 2020 and 2021 were the most problematic years after the digital transformation of entertainment due to COVID. To spend time at home, people moved to in-door entertainment including streaming, virtual events [43], online gaming, and virtual tourism [44]. The entertainment industry expects a loss of around USD 160 billion for the next five years, as reported by Ampere Analysis. Numerous sporting events and

concerts have been postponed or outright canceled. According to Disney, the pandemic cost a loss of USD 2.4 billion in operating income during the Q4 of 2020 for its parks and products segment. Even with promising vaccines on the horizon, recovery could still be spotty, especially for the theatrical sector, where audience behavior may have changed for good. The Metaverse can help the entertainment industry in immersive storytelling, world-building, and further unlocking fan creativity. These features offered by Metaverse can enhance audience engagement virtually for the modern entertainment brand.

Metaverses will also enable experience-oriented entertainment brands to test virtual venues that transcend the limitations of physical venues and unlock new types of experiences [45].

In 2021, US reality TV show star Paris Hilton launched her Metaverse business on Roblox [46]. Her virtual world, named Paris World, allows visitors to explore digital replicas of her Beverly Hills estate in a luxury sports car or Sunray yacht.

3.5. Potential of Metaverse in Healthcare

In healthcare and medicine, immersive technologies have been proven helpful for realistic and interactive simulations [47]. These technologies also support cognitive rehabilitation to recover from neurological disorders [48]. The convergence of virtual and physical space in the Metaverse could help to advance healthcare and medical training. Replacing conventional technology with Metaverse can expand the user experience of medical education. Application of the Metaverse in medical training [49] will provide more effectiveness where hands-on learning and advanced interactions are required. In addition, it will move the concept of the metaverse from virtual space to haptic feedback with more realism.

A Metaverse for Burn Hospital was established on the Gather Town platform to conduct various lectures and workshops [50] where users reported this experience as fun and evaluated it positively. The Metaverse can unlock new potential in the realms of telehealth h [51] and remote patient care [52]. Elevating the virtual care concept from a 2d to a 3d experience can bring a revolution in medicine [53,54]. The Metaverse can help medical students with immersive simulations for medical training, practice procedures, and diagnostic techniques in virtual environments.

3.6. Potential of Metaverse in Governance an Politics

The World is changing fast, and to keep up with the new opportunities and challenges, governance technology is also evolving quickly. The hybrid working concept can bring more opportunities for Governments towards sustainability [55], by lowering the cost of running infrastructure and reducing the need for mobility. In addition, it will create new employment, improve the traditional learning system with interactive learning environments, deliver remote healthcare, and plan urban spaces.

In the very near future, Metaverse can also serve as an essential public services provider, social initiatives [56], more advances like Decentralized E-Voting Systems [57] as governments can jump into the rapidly expanding digital World; however, it will need policymaking at large to control the ethics and privacy issues [58]. The capital of South Korea, Seoul is planning to become the World's first city to offer civil administrative services via a Metaverse platform [59].

3.7. Potential of Metaverse for Architecture

Metaverse can be a potential for the design process [60], as the Bodily Metaverse of Lisbon architecture design shows [61]. The potential architecture community has seen the rapid development of virtual reality, creating and visualizing the progressing World's environments. In the real world, architecture helps in social services like housing and social entertainment. In addition, new technological advancements created possibilities for replicating the physical space into artificial [62,63]. Also, the virtual buildings in the Metaverse are easy to transform as compared to the real buildings. People only need to

modify the code in the computer to overthrow a building and rebuild without considering new financial resources.

3.8. Potential of Metaverse for Virtual Real Estate

Metaverse is an online space of interconnected 3-D worlds emerging as the hotspot for multi-million virtual real-estate investments.

Even the investors cannot live physically in these virtual experiential spaces. In early 2021, a digital artist named Krista Kim sold a digital house valued at nearly USD 500,000 as an NFT [64], as shown in Figure 10.

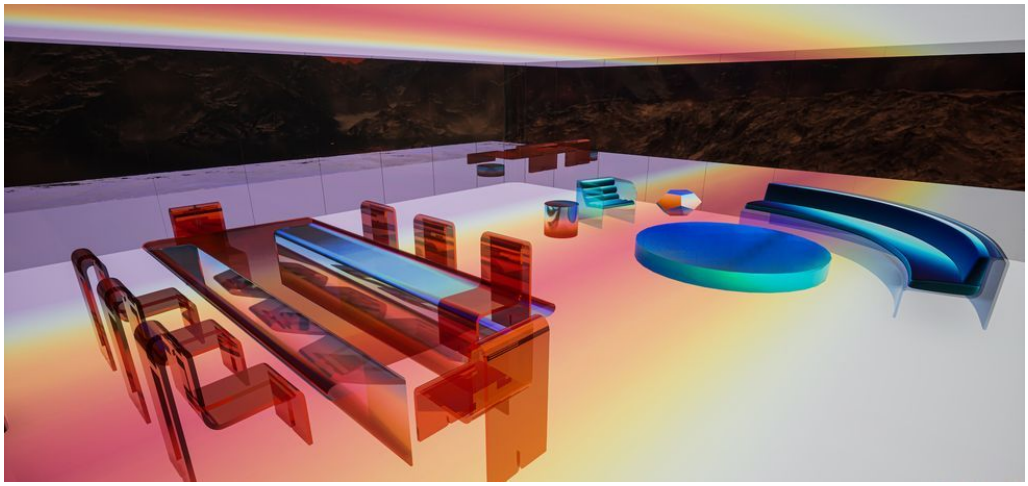

Figure 10. NFT (non-fungible token) digital home 'Mars House' sold for USD 500,000 [64].

In 2021, another purchase of virtual land happened in Decentraland valued at USD 2.43 million, which is the highest value to date in the virtual world and considered as higher than the average home price in Manhattan [65]. These purchases are purely speculative of future potential use and will be difficult to assess if these virtual worlds will actually be used in the future. It its as simple as a new world becomes popular, and the value of these virtual lands is reduced to nothing. In this case, they negative value there is a real-world cost to running the servers behind these virtual worlds.

3.9. Potential of Metaverse for Fashion Industry

Just like other industries, the Metaverse is also enhancing opportunities in fashion. The fashion industry has already adopted augmented and virtual technologies to a certain extent as virtual try rooms [66] and continues with the progress of immersive technologies, it's bound to be even more prominent.

In 2021, British Fashion Council, partnering with Roblox launched a new award category named as the "Fashion Award for Metaverse Design" [67], can be seen in Figure 11. As our social lives are changing the way to communicate and live, this change is not surprising, and the World's favorite brands are jumping to "digital" platforms.

The World's well-known sportswear giant Adidas partnered with a major cryptocurrency exchange Coinbase to explore the sports and fashion potential in the Metaverse as starting with the virtual gaming blockchain The Sandbox [68].

Fashion giant Diesel and Margiela's Owner Only The Brave (OTB) has formed a new division called Brave Virtual Xperience (BVX) for designing products and gaming experiences in the Metaverse. BVX will be entirely for the development of Metaverse-related fashion products and experiences to keep the customers engaged with the booming wave of Metaverse as a luxury fashion house for the future [69].

Figure 11. The Metaverse version of The Fashion Awards 2021 in a virtual Royal Albert Hall [67].

3.10. Potential of Metaverse for Virtual Heritage and Festivals

Metaverse can open up to heritage sites and virtual festivals by introducing realism in the virtual. Virtual presence and virtual realism [70,71] are the two most important things to having a realistic virtual experience. The first Metaverse festival was organized by Decentraland in October 2021 [72]. With the development of VR at a crucial point, considering the emerging virtual heritage and its potential values are essential. In 2021, to explore the opportunities of immersive celebrations, a wedding ceremony was held in the Metaverse using Virbela software [73]. It shows the virtual possibilities to participate, in the restricted times of COVID.

3.11. Potential of Metaverse for Diversity and Inclusion

The Metaverse will bring a massive opportunity for diverse voices and creators when considering diversity and inclusion [74]. It can attract diverse audiences, whatever age, race, gender, culture, or sexual orientation they belong. However, in terms of accessibility, it will require more expensive computers with VR headsets and high-quality cameras to get in. Virtual worlds can be designed by keeping the accessibility needs in mind to accommodate mobility impairments and visual or hearing impairments [75,76]. The Metaverse can help in safer cross-cultural interactions by allowing people from diverse backgrounds to connect, collaborate, and learn. This will help to promote empathy and contribute to a more inclusive global community. Issues related to providing digital access, protecting privacy, and creating virtual spaces that real-world inequalities must be addressed to realize the positive potential of the Metaverse [77].

3.12. Metaverse, Blockchain, and Cryptocurrencies

Blockchain technology and decentralized platforms have proven to be adaptable in the mainstream due to immutable and unhackable features. Cryptocurrencies are considered the key to the Metaverse, especially in the gaming world [78]. The use of blockchain technology in virtual reality and the virtual world changed from little [79] to massive in just a concise period of time. Potentiality, Metaverse can open up numerous possibilities, but the real factor is the user. Traditionally, virtual worlds are created and owned by people and big companies. Still, crypto Metaverses are typically decentralized [80], with some or all components of Metaverse games built on blockchain technology. That clarifies the blockchain Metaverse tendency toward diverging from the gaming industry's mainstream business models and value-generating models. The blockchain's ability for decentralization can open up more equitable engagement and opportunities among the participants in the games. It will give all participants ownership of the Metaverse world; even if the real

creators walk away, the game could exist in perpetuity. Some of the hot coins that emerged in the first wave of Metaverse crypto are:

- Decentraland (MANA) [81];
- Sandbox (SAND);
- Enjin Coin (ENJ);
- Meta Hero (HERO).

4. Trust, Ethics, Cognitive Load Issues

New inventions always come with their positive and negative sides. Thinking about, *how will the Metaverse affect trust in the workplace?* Issues like feeling watched when working remotely and questions about *who will be watching your interactions in the metaverse?* and *how much time do you spend in the virtual office?* [82,83].

Thinking about *how to police inappropriate behavior of virtual working?* It can feel like walking in a video game, working together detached from reality, and moving the teamwork effectively. The next thing to think about is about *how long can someone be expected to wear a HMD realistically to spend time in the Metaverse?* and *willingness of people to wear such gear.* These questions have huge importance for the ambitious vision of the Metaverse [84]. Establishing trust in the durability of digital presence is paramount. In addition, standardization is needed to enable the interoperability of platforms and services across the Metaverse. Like other technologies, widespread adoption of the Metaverse will require essential technological standards just like IEEE global XR ethics initiative report [85].

This call for standardization is not to argue for a wholly "holistic approach to build the Metaverse" [86] as others have argued for. Digital twins will be used, as mentioned before in this paper, and many worlds will partner with each other to create rich ecosystems. No matter how well each world attempts to make its worlds holistically, gaps will emerge from technology components to the mental and social factors its users face. These gaps will lead to black markets and use cases of worlds completely unexpected. Attempting to control this will lead to a monopolistic approach, leading to a convergence of control that may appear initially to avoid some of the harms of monopolization from companies like Apple or Meta. Still, it ultimately could stop this technology from being an overall good for humanity. It could be concerning that many companies will lobby to regulate the Metaverse to protect the public while creating an impossible barrier of entry for competing for free alternatives. Creating a new virtual land only costs the price of running a new server and not paying an exorbitant price for an area of the Metaverse accessible to the public due to regulatory and not technological grounds. Augmented reality worlds within the Metaverse may not suffer this problem as with their coexistence in the real world; local ad hoc networks could guarantee access. This splintering of the Metaverse should not be a concern; Strength through diversity will out-compete closed systems. Rejecting a single governance model [87] such be prioritized.

The ethics of interaction between the virtual and the real world will prove challenging and may become one of the defining questions of the 21st century. The Metaverse offers such unique potential for all of humanity for good. Still, already elements of artificial scarcity [88] where attempts to use real-world property laws lead to cases of deductive explosion where any proposition can be supported due to contraction being asserted as true. As mentioned earlier in this paper, Blockchain technology offers a decentralized approach with the implementation of smart contracts that could help balance the interactions between real and virtual contracts [89]. However, new shared worlds will always be possible; hence a Metaverse space where A to Z is restricted will always have the possibility that a divergent member of the group will set up a space where B and H are allowed, but A, C, D, E, F, G, I, and so forth are still not permissible. The Metaverse spaces ultimately will not be restricted by rules decided by their users but by real-world copyright and the law of the land in general where the servers hosting the world are placed. Feedback loops could, off-course, occur where although A is not permissible in the real world, the lack of oversight creates worlds where A happens so regularly, then A is made acceptable in the real world.

By its nature, the Metaverse embodies the concepts of Berkley [90] Subjective idealism as the objects truly only exist in a state that is "to be is to be perceived".

A Metaverse allows for the existence of an unlimited number of shared virtual worlds, and it's interesting to note that this is a reflection of current scientific [91] and contemporary media culture [92] obsession multiverses. With such popularity of the notion of a multiverse, adopting a Metaverse consisting of shared realities both directly connected with our physical world in AR and existing independently in VR will be trivial to younger generations. Crucially though, one must remember, especially with the use cases outlined in this paper and with the addition of haptics, we will genuinely have a sensation of matter within these worlds, and interactions within these worlds will have real-world consequences ethics must always be considered.

With an immeasurable potential, the concept of the Metaverse is the biggest thing when it comes to immersive digital workplaces, health services, gaming, and customer experience for the growing contingent of brands with the adoption of the technology [93].

Each new digital experience from an event, NFT, or getting player support can be recreated in-game or in-world to increase frictionless customer engagement. Emerging technologies like 5G will help in high speed and transmission power to make this artificial world functional. Modern digital devices need the support of big advancements to provide latency-free experiences through virtual and augmented reality using 5G and upcoming technologies [94].

Most of our digital interactions are based on 2D imagery, changing rapidly like virtual tours of places. The Metaverse requires many innovations in current technologies, protocols, innovative enterprises, and discoveries to make them functional in the real world. In the market, there are several competitors in the development of hardware for virtual, augmented, and mixed reality, including Apple, Facebook (Meta), Google, HTC, and Microsoft [95]. Therefore, there is a need for strong computing power to be embedded in a frame of glasses to create possibilities for making the technology convenient. It is possible by focusing on the decreasing size by including the computer and networking chips [96], holographic waveguides [97], sensors, batteries, and speakers in the tiny space.

5. Conclusions and Future Recommendations

Combining all emerging technologies forms an entirely new virtual universe that may offer tangible and meaningful experiences. Metaverse is years away from a point where it is genuinely pervasive and accessible to all. Once it becomes possible, AR and VR will become ubiquitous in everyday life. Our current Internet communities and online spaces form a beta Metaverse [98]. However, these changes will not happen overnight because it will take time to complete this transition for accessible, interactive, immersive real-world experiences to become a reality. Control of such worlds should not be controlled by one group or well-meaning regulation that results only in nation-states or large corporations controlling and running such a world. There is a need for standards to be developed to ensure smooth communication and interaction within the various components of the Metaverse. To create these virtual worlds more user-centric, there is a need to focus on creating intuitive, immersive, and engaging user experiences. In the future, user interfaces should accommodate a wide range of users, from tech-savvy to people less familiar with digital technologies. In terms of data, as the Metaverse will involve extensive data sharing and interaction, to protect user data, privacy and security measures should be at a high level. Governments and regulatory bodies will require to focus on establishing frameworks for ensuring fair practices, preventing abuses, and protecting user rights in virtual environments.

In the past, there was a lack of resources for creating 3D content, which has been removed effectively by developing the ability for high-definition content, virtual representations and authoring toolkits [99]. The Metaverse is reliant upon the power of 3D capture and virtualization technologies. From virtual gaming, world workplaces, fashion or entertainment, and even for public services, the Metaverse can bring tremendous oppor-

tunities to form an entirely new way of living, the same as the Internet has performed in the last 30 years. We would need 3D capturing and advanced virtualization technologies for developing digital twins to provide a virtual realm. There is no doubt; the Metaverse will continue to integrate into our lives and expand further, creating new opportunities [100]. Metaverses can bring a robust creative canvas that will enable organizations to provide incredible new opportunities in virtual business and collaboration for employees.

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Abbreviations

NFT	Non-fungible Token
AR	Augmented Reality
VR	Virtual Reality
MR	Mixed Reality
IEEE	Institute of Electrical and Electronics Engineers
SAND	Sandbox
ENJ	Enjin

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